FISH OF DEOLALI.

Part II.

Ecological and Biological Observations.

(With one plate).

BY

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Contents.

Prefatory Note.

The following series of notes contains ecological and biological observations made by Mr. A. G. L. Fraser on certain fishes of the Deolali area both under field and laboratory conditions. The author used vernacular names in his descriptions but I have given the corresponding scientific names of the species throughout; in places the text has been revised so as to bring it in conformity with the literature on the subject. Explanatory notes have been added wherever it was found possible to give some adequate reasons for the valuable facts observed by Mr. Fraser. Dr. Albert W. C. T. Herre happened to be in Calcutta when I was revising these notes, and I availed myself of this opportunity to have the matter looked over by him. He very kindly read the revised manuscript and was able to add a note on the surface-swimming habit of the Cyprinidae of the Far East.

The observations recorded here by Mr. A. G. L. Fraser are extremely valuable, especially as they are based on abundant material and were carried out during all the seasons of the year. Special attention may be directed to the function that has been assigned to the hypertrophied lower lip of *Rasbora labiosa* Mukerji and *Danio fraseri* Hora. From an analogy of similar structures found in certain Amphibian tadpoles, it was presumed by Mukerji and the writer that the structure was probably used for hanging from the surface film; but Mr. Fraser has conclusively shown that the enlarged lower lip is meant to seize and hold insects for which the fish jump several inches out of the water. This shows how similar structures may sometimes be used for totally different functions.

The arrangement of matter proposed in the first part had to be modified as the descriptions of new species and notes on rare forms could not be completed in time for inclusion in this part of the *Journal*. In some respects the present arrangement seems to be more suitable.—*S. L. Hora.*

1. A Note on the High Mortality Incidence Observed Amongst Surface and Ground Fishes (Excepting the Ophicephalidae) on their Transference from the Natural Environment to an Aquarium.

In the experiences connected with the keeping of fishes in an aquarium, the problem encountered and beset with difficulty was how best to reduce the high mortality which invariably occurs amongst any given number of fishes on their introduction into the aquarium. A rough assessment of this mortality rate shows that 30 per cent die almost at once or within a few hours of the transference. A further 30 per cent. die within 24 hours and 10 per cent. up to 48 hours. In studying these losses with a view to reduction of mortality, the various factors prevailing in the water of the aquarium i.e. (1) temperature (2) alkalinity (3) absence or presence of currents (4) mechanical aëration (6) food supply and (7) the physical character of the bed and the surroundings, were considered in turn and, despite all practical efforts to bring conditions in the aquarium to approach as near as possible those of the river or streams, the mortality figures continued fairly constant. Excluding the *Ophicephalidae,* which were tenacious of life, with a death rate of only 10 per cent., the surface fishes generally showed a higher proportion of deaths as compared with other ground species. No matter what kind of water was used, whether from the river, stream, well or tap, the relatively small percentage of species which ultimately survived were those able to live in any kind of water, provided always, that it was slightly alkaline to litmus paper. Such fishes lived for the five months of observation, even when, as was the case with one batch, the water had not been changed for eleven weeks.

Of the surface fishes, roughly 30 per cent. of the following species survived the transference and showed clear indications of a very high physical capacity for adapting themselves to the conditions in a small improvised aquarium.

(1) *Barbus ticto* (Ham.).—Bhil name :—*Tiptoo*
(2) *Rasbora labiosa* Mukerji.—Bhil name :—*Gayroonjee*
(3) *Danio fraseri* Hora.—Bhil name :—*Gayroonjee*

All these species are found in both rivers and streams in this area. Excepting the first, the two others are normally more numerous in the streams.

In the case of *Barilius bendelisis* Ham. (Bhil name :—*Jhor* or plural *Jhoria*) the mortality in the early trials was cent per cent. Later, it was ascertained that if salt was added to the water in a quantity sufficient to render it strongly alkaline to litmus paper, the death rate was reduced to 90 per cent. Any further additions of salt did not improve the situation and 10 per cent. of any given number survived and could live on if the water was brackish.

Amongst all other surface species which were recovered from the rivers there was a high degree of susceptibility—from 15 minutes to two hours at most—with a cent per cent. mortality which could not be influenced under any circumstances. This I

think can be attributed to the absence of strong currents which it was impossible to reproduce in a small aquarium. In this respect the Chilwa [*Chela clupeoides* (Bloch)], Bhil name—*Phal* or plural *Phalay* and *Ambassis ranga* (Ham.) with the Bhil name of *Bing* are notable as they were found associated together in sections of the rivers where there were very strong swirling currents in evidence.

The ground species, excepting the *Ophicephalidae,* showed generally a 50 to 60 per cent. mortality and the fishes which best adapted themselves in the improvised aquarium were the following:—

(1) *Cobitidae*: There were four species, viz., *Lepidocephalichthys guntea* (Ham.), *Nemachilus botius* (Ham.), *N. denisonii* Day and *N. evezardi* Day. All of these lived well in the aquarium, but one of them, *L. guntea* (Ham.), with the Bhil name of *Mohroo chopra,* proved to be the better adapted as it lived through the six months of observations.

(2) A ground species (Bhil—*Kharandya*) [*Garra mullya* (Sykes)].

(3) A Siluroid:—Bhil name, *Khirkirya* [*Mystus cavasius* (Ham.)].

In the case of *Garra mullya* (Sykes)—Bhil name, *Mallia*—there was a fifty per cent. death rate but the surviving numbers did not live for more than 4 days in the aquarium and during this period showed much respiratory embarrassment. They periodically and frequently rose to the surface and by muscular action alone, maintained themselves perpendicularly suspended, but not by their lips, for 30 to 35 seconds. While thus engaged, they create a froth of bubbles. This species is really not a good aquarium type. Other ground species showed a cent per cent. mortality.

Most of the ground species were recovered from the rivers. The *Cobitidae* appear to be generally distributed in both the rivers and streams.

The results of the observations made it clear that in a small improvised aquarium only those species survive which are habituated to living in still water pools of rivers and streams or in pools where the currents are only of slight intensity. It would appear, therefore, that if other species are to survive in an aquarium for purposes of observation the water in it must be so arranged that strong currents[1] pass through it at all times and, while allowing of a wide surface expanse its volume and depth must be adequate. These conditions, plus a slight alkalinity and a bed of a varied nature consisting of rock, sand, silt, and under water vegetation to suit the different kinds are equally necessary. It has not been possible for me to do this.

[1] Owing to strong currents, the water becomes well oxygenated and it is usually difficult to keep rapid-water forms in aquaria. By aërating aquarium water artificially, it is, however, possible to acclimatise a certain number of these fishes to aquarium conditions.—*S. L. Hora.*

The question as to why there should be a high mortality rate amongst the species, of which a small percentage were able to survive the ill-adjusted conditions in a small improvised aquarium, is of interest. Theoretically, if conditions were so adverse as to kill the majority none should have survived. Whether death of the majority was due to shock as the result of a highly nervous complex reacting badly to the new environment is a possible causative factor but not easily ascertainable; but there is no doubt that the few surviving individuals showed a capacity and resistance of a high and peculiar quality, apparently inherent in themselves, for, though placed in an ill-suited environment, they were quite at home in it. Were it not due to this high adaptive power of the few it would not have been possible to carry out the experiments and observations of which the records are appended.

It is possible also that the range of variability is much less among the survivors than in those eliminated. This was found to be the case by the American zoologist, Bumpas who measured 136 injured specimens of the common sparrow collected after a severe storm. Out of this number 72 revived while 64 died. On measuring the dead birds and comparing them with the survivors he ascertained that the former on the average were longer and heavier than the latter and significantly also showed that the range of variability was distinctly smaller among the living birds. In this respect the transference of fishes from their natural environment to the aquarium can be likened to a storm. Unfortunately I am not competent to undertake these measurements of the fishes involved. Such measurements if they are to be reliable must be undertaken on freshly dead specimens as preserved fishes are unsuitable for obvious reasons of shrinkage. I have, however, put up separately in two lots such batches as were observed.—(1) Those that died almost at once or within 48 hours and (2) the numbers which ultimately survived and would have continued to live indefinitely had not the observations terminated for lack of facilities. Should these fishes be measured and the comparative study reveal physical differences it should furnish valuable evidence that those individuals which depart least from the 'ideal type' have on the whole the best chance of surviving.[1]

2. Notes on Distribution and Habits of Certain Fishes.

In the course of making the collection and from the experiences and impressions gathered after eleven months exploration of the tributary streams and rivers in the Deolali area the following

[1] Dr. S. L. Hora of the Zoological Survey of India, who, in collaboration with Mr. K. S. Misra, has investigated the fish fauna of Deolali informs me that the specimens kept in the aquarium for a long time are very lean and attenuated. In fact he found them so different from the normal individual that in the preliminary sorting he regarded them as belonging to different species. This was particularly so in the case of *Lepidocephalichthys guntea* (Ham.) and *Danio fraseri* Hora. Such a condition was probably due to insufficient nourishment under aquarium conditions.

features were noted as regards the distribution and some of the habits which have been observed.

Serial number and number in order of dominance	Scientific Name	Bhil Name	Present in rivers	Present in streams
1. (29)	*Notopterus notopterus* (Pallas.).	Chambree ...	X	...
2. (33)	*Anguilla anguilla* (Ham.) ...	Ahlir ...	X	...
3. (7)	*Chela clupeoides* (Bloch) ...	Phathree, Phal ...	X	...
4. (2)	*Barilius bendelisis* (Ham.) ...	Jhor ...	X	X
5. (11)	*Danio fraseri* Hora ...	Gayroonjee.	X	X
6. (32)	*Rasbora daniconius* (Ham.) ...	Gayroonjee.	X	...
7. (3)	*Rasbora labiosa* Mukerji ...	Gayroonjee.	X	X
8. (30)	*Aspidoparia morar* (Ham.) ...	Ambli ..	X	...
9. (17)	*Barbus chola* (Ham.) ...	Bhokria ...	X	...
10. (5)	*Barbus khudree* (Sykes) ...	Waris ...	X	...
11. (6)	*Barbus kolus* (Sykes.) ...	Kholis ...	X	...
12. (15)	*Barbus sarana* (Ham.) ...	Bhodeer ...	X	...
13. (1)	*Barbus ticto* (Ham.) ...	Tiptoo, Tiplee ...	X	X
14. (16)	*Cirrhina reba* (Ham.) ...	Arrol ...	X	...
15. (24)	*Crossichilus latius* (Ham.) ...	Warootee ...	X	...
16. (4)	*Garra mullya* (Sykes) ...	Mallia, Kharandya ...	X	X
17. (10)	*Labeo boggut* (Sykes) ...	Sandekol ...	X	...
18. (23)	*Labeo porcellus* (Hackel) ...	Khanoos, Ghoghir ...	X	...
19. (27)	*Rohtee cotio* (Ham.) ...	Goorda ...	X	...
20. (28)	*Rohtee vigorsii* (Sykes) ...	Kuplee ...	X	...
21 (12)	*Lepidocephalichthys guntea* (Ham.)	Mhorroo, Mohroo thail, Mohroo chopra...	X	X
22. (13)	*Nemachilus botius* (Ham.) ...	Mhorroo, Mohroo chickna.	X	X
23. (14)	*Nemachilus denisonii* (Day.) ...	Mhorroo, Mohroo yaree ...	X	X
24. (18)	*Callichrous bimaculatus* (Bloch)	Monee ...	X	...
25. (22)	*Wallago attu* (Bloch and Schn.)	Baloo ...	X	...
26. (9)	*Mystus cavasius* (Ham.) ...	Khirkirya ...	X	...
27. (31)	*Glytothorax lonah* (Sykes) ...	Khordoo ...	X	...
28. (21)	*Nangra viridescens* (Ham.) ...	Bibua ...	X	...
29. (25)	*Proeutropiichthys taakree* (Sykes)	Sonar ...	X	...
30. (20)	*Ophicephalus gachua* (Ham.) ...	Dhakay, Dakhia ...	X	X
31. (26)	*Ophicephalus marulius* (Ham.)	Murral ...	X	...
32. (8)	*Ambassis ranga* (Ham.) ...	Bing ...	X	...
33. (19)	*Glossogobius giuris* (Ham.) ...	Kharbya ...	X	...

In the above Table the species are shown as found (*a*) in the rivers and (*b*) in the tributary streams; their order of

dominance is also noted. The order of the dominance shown is judged by the numbers taken of each species and is possibly not quite a true index, but it is near enough for all practical purposes. It will be observed from the Table that, of the total of 33 species tabulated, quite a large number found in the rivers, were not found in the streams. Nine species only of the total were found in both the rivers and streams. Of this number only three can be said to be truly stream species. These are *Rasbora labiosa* Mukerji, *Danio* (*Danio*) *fraseri* Hora and a ground species with the Bhil name of *Kharandya* [*Garra mullya* (Sykes)]. Their presence in the rivers can be accounted for by the fact that the monsoon storm waters force them in. During the dry seasons of the year their numbers in the rivers are comparatively scanty, while in the streams they are very numerous. The remaining six species appear to be equally distributed in both the rivers and streams.

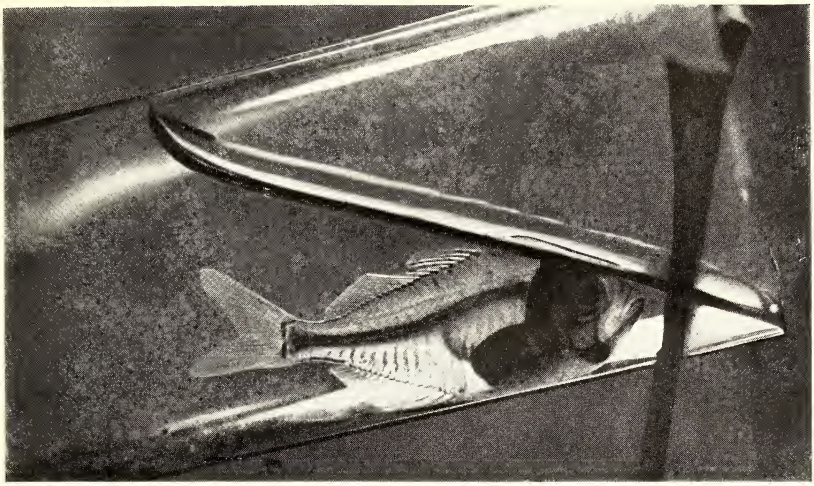
Chela clupeoides (Bloch).—Bhil name, *Phal* or *Phalay*.

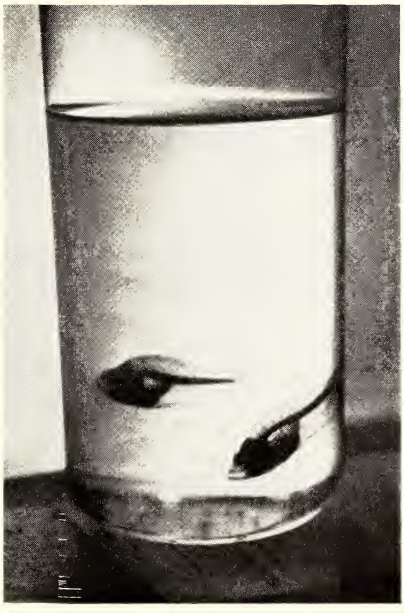
A long, laterally compressed, silvery white fish, stained greenish yellow dorsally. The ventral surface is arched in the long axis; dorsally it is concave, with a sharply upturned mouth. They are recoverable only from the rivers, most often in midstream where the currents are swirling and strongest and in sections where the bed is rocky and sanded or part silted. They move about in shoals and prefer stretches of the river which have a wide expanse, and are absent from sections where there are villages upon the banks. They have been found associated with what appear to me to be *Ambassis ranga* (Ham.), (Bhil name, *Bing*)—a fish so pale and transparent that when alive, the vertebral column, and anteriorly below it and wedged above the stomach, the swim bladder and the bones in its body are clearly defined. After death it becomes opaquely white. With the *Chilwa*, it shares a preference for localities where there are strong currents. *Chilwa* are particularly susceptible and do not live for more than a few minutes in the aquarium. Ten per cent of the *Bing* are capable of living in the aquarium. They never rise to the surface at any time and do not behave as other surface species do. They remain stationary the whole time and rarely if ever move about keeping a position about 2 inches from the floor. They readily devour larvae and also green algae. The mouth is always kept open and only the lower lip is slightly raised in the act of breathing. The *Chilwa* is insectivorous. I have seen them rise to take small blue dragon flies.

Barilius bendelisis (Ham.).—Bhil name, *Jhor* or *Jhoria*.

Hora and Mukerji in the *Records of the Indian Museum,* vol. xxxvii, part iii, have mentioned two species of Barils in their report on the small collection which was first sent from Deolali. The name *Jhor* is used by Bhils for both species. *B. bendelisis* is dark-coloured dorsally with yellowish fins and a series of transverse jet black or purplish black streaks running from a dorsal ridge to the mid-body near the lateral line. In spirits, the dark dorsal colouration

[1] The material sent to us for examination does not bear out, in a few cases, the order of dominance of the species as noted by Dr. Fraser. It is quite possible, however, that we did not have the whole material for examination.—*S. L. Hora.*





Photos showing the transparency of the fish *Ambassis ranga* (Ham) known to Bhil fishermen by the name of *Bing*. The swim bladder and vertebral column are clearly defined.

of large specimens fades to yellow. The young show lighter colour tones and the transverse streaks are much more pronounced. This fish is found both in streams and rivers and favours parts which are silted up and where there is only a mild surface current. During dry periods of the year they are more numerous in the streams, especially in the sections of the 'North Nallah' which run by the Deolali Cantonment Bazaar. Here there is much washing of clothes done and the water is soapy and foul-smelling. Batch No. 32[1] in the present series is a good example of a catch of this species only, containing both large and small specimens taken from the locality mentioned. The water here is always strongly alkaline to litmus paper. This is an important point as this species is a bad aquarium type and I have mentioned previously that a cent per cent. mortality was reduced to 90 per cent. simply by adding salt in sufficient quantity to make the water in the aquarium strongly alkaline. Curiously enough, Batch No. 37 taken on 30th January 1936 from the Darna river were all very young specimens which were caught at the sides of the river in a portion which was but a few inches deep and where there was no current. The bed was a silt-covered sanded section, and here also the water was strongly alkaline, while the temperature at 3 p.m. was 86°F. In contrast with this, the water at a 2 ft. depth in the current of the river was slightly alkaline and the temperature 76°F. No big specimens of this species were caught in this locality on that day. Confirmatory proof of the fact that only this species is recoverable in the section of the 'North Nallah', referred to above in connection with Batch No. 32, is again furnished by the catch obtained on 10th February 1936. Batch No. 39 (see also Batch No. 50 of this series) contains this species. On this day the temperature at 4 p.m. was 86°F. and the water was strongly alkaline. These fish feed well on mosquito larvae and leap for midges when they fly above the surface level. Batch No. 11 containing three specimens were taken on rod and line with a worm bait on 29th August 1935. I have since ascertained that they swallow worms readily. Worms can be got at any time of the year from the section of the North Nallah where this fish is found. The bed is silted over a rocky base and the worms are to be had in the silt and from the edges of the stream. The fish have been observed to partly bury themselves head up in the silt and some have been caught in this way by simply removing the silt and picking them out from it. I have tried silt in the aquarium but this does not help to reduce the mortality. Egg-bearing females were found in March.

Danio (Danio fraseri) Hora.—Bhil name, *Gayroonjee.*

Much of what is given below as regards the habitats of *Rasbora labiosa* Mukerji equally applies to this species which is insectivorous probably throughout its life. The colour in the living state is silvery with a pinkish blush which is also in evidence on the fins. The lateral striations on the long axis of the body are of a blue

[1] These numbers correspond with the locality numbers as given in Part I of the present series.

colour which fades to just perceptible lines when the fish are kept in the aquarium for any length of time, when they also lose the pink blush, becoming silvery white. In spirits, the striations become quite dark and much of their original freshness is lost.

Rasbora labiosa Mukerji.—Bhil name *Gayroonjee.*

This fish is easily the dominant type in the streams, where they are very numerous. At the origin of the 'Narsullah Wadi' (see bach No. 14—12th September 1935) they were found associated with *Nemachilus denisonii* Day (Bhil name, *Mohroo yaree,* a banded fish). During the dry months of the year comparatively few are recoverable from the rivers, where only adult specimens measuring from 4 to 6 inches in length are usually present. In the streams they have been observed moving about in small shoals—of about 40 or more, consisting chiefly of the smaller fry. They are nearly all of uniform size and appear to have been hatched out at the same time. Very young ones 1.0 cm. in length have been found in the shallows of sanded beds at the edges of the streams where they can be caught by cupping one's hand into a hollow. This is a hardy fish and makes a good aquarium type. They are capable of living in very foul water and were recovered from stagnant pools and the marshy pockets of the streams which become clogged with algae and show a heavy surface scum. Significantly enough 80 to 90 per cent., taken from the stagnant sections survived in the aquarium, provided they were kept under identical conditions in the same kind of foul water with algae in it. A batch was kept for eleven weeks continuously without the water being changed without ill effects. When placed in clear well water the majority of them died within six hours. In contrast with this only 30 per cent taken from clear water in the cleaner parts of the streams, where there was a fair surface current survived in the aquarium. During the rains they are taken in fair numbers from the rivers into which they are washed by the monsoon flood waters. Those in the streams are larvivorous and insectivorous. They feed greedily on the larvae of mosquitoes and midge flies and leap out of the water as much as ten inches high to take flying insects above the surface film. They also feed readily on algae and the flour of a millet grain called in the vernacular 'Bajri' but much prefer adult mosquito and midge flies.[1] The midge flies are seen in the characteristic clouds of their nuptial flight after the rains give over and during the cold months up to February. They appear in numbers at eventide and also at times during the day in flight above the streams. They are particularly in evidence above the stagnant sections and *Rasbora labiosa* and *Danio fraseri* then become very active leaping out for them. Several large specimens of *Rasbora labiosa* were taken on rod and line with a worm bait. One specimen, four inches in length, kept in the aquarium preferred a diet of worms, which it readily devoured and eschewed the larvae and imagos of the insect mentioned. One particularly large example of this species was netted

[1] Mr. Prater in a letter states 'The midges which you sent from Deolali were identified in the British Museum as *Chironomus tripartitum* Rieff.'

in the act of swallowing a *Nemachilus*. This evidence would go to show that the smaller fry are insectivorous and when grown to adult proportions become carnivorous.

In the publication 'Notes on Fishes in the Indian Museum, xxv. On two New Species of Cyprinid Fishes from Deolali' etc., —*Records of the Indian Museum*, vol. xxxvii, Part II, pp. 375-80, Hora and Mukerji emphasise the characteristic hypertrophy of the lower lip in *Rasbora labiosa* Mukerji and *Danio fraseri* Hora. In the absence of biological observation they found it difficult to assign any definite function to this structure, but directed attention to homologous structures found in certain tadpoles which are supposed to use the hypertrophied lip as a device for hanging from the surface film. They therefore think it is possible that the two new surface species also use the expanded lower lip for the mechanical process of suspending themselves from the surface film when the waters in their habitats become too foul for the ordinary process of respiration. With a view to ascertain whether they behaved in this way, observations were maintained over them and incidentally also over other surface and ground species for a period of five months from 1st November 1935. In the previous notes under mortality incidence, no details were mentioned as to the behaviour of the fishes on the initial transference from their natural environment to the aquarium. The description of this behaviour was postponed for consideration here. The majority of the surface fishes, inclusive of the two new species observed, as also those of the Siluroid family and the ground fish *Garra mullya* (Sykes) (Bhil names: *Mallia* and *Kharandya*) when introduced into the aquarium and dependent upon their powers of adaptability manifest a marked respiratory embarrassment. This they show in the following way. As regards the surface species, the ill adapted rise to the surface and by muscular action alone in the act of swimming maintain themseves as if suspended from the surface film. At the same time the mouth movements in the act of breathing become considerably accelerated; the mouth itself is opened wider and the gill covers are seen to heave to aid respiration. All of these symptoms clearly show the dyspnœa to which they become subjected. In this respect all the fishes behaved alike and in no single instance was there any evidence to show that in this distressed condition they made use of the lower lip in a mechanical way to hang from the surface. Occasionally in the act of swimming the dorsal aspect of the head and sometimes the upper lip was pushed above the surface level, but never the lower lip. When at the surface, the position of the body in relation to the surface film forms angles of a varying degree according to the species. In the case of *Rasbora* the angle formed is roughly 30, of *Danio* 40, of *Barilius* 30, of *Barbus ticto* 60 and of the Siluroids 40 to 60 degrees. They continue to behave in the way described until a moribund phase ensues when they turn over on their backs and finally in a short space of time die. With regard to the ground species referred to above, the behaviour is different. They do not swim about at the surface; instead they remain clinging to the surface by muscular effort in a perpendicular position for half a

minute or so and then sink back again, repeating the process until moribund and unable to do so any longer. While at the top this ground species produces a froth of bubbles. A similar behaviour, but in a much less active form than the exaggerated behaviour described above, has been observed as a normal daily feature amongst the surface fishes and is regularly resorted to by them as an evening exercise. This form of exercise is unattended by any mortality and will be later discussed in a separate note to follow. As a result of these observations it may be remarked that the hypertrophy of the lower lips and the upward projection of the mouths in the two new Deolali species rather appear to indicate a line of development consistent with their feeding habits. All the evidence gathered with regard to their habits and habitats clearly show that the younger forms of *Rasbora labiosa,* Mukerji are definitely insectivorous, while *Danio fraseri,* Hora is undoubtedly so, probably throughout its life. The rounder and longer bodies of *Rasbora labiosa* are admirably suited to leap out of the water (ten inches) in taking mosquitoes and midge flies which they never fail to secure once they rise. In contrast with them, *Danio fraseri* is unable to rise higher than 4 or 5 inches above the surface level possibly because of its flatter body and shorter length (the largest caught here has not exceeded 4 inches in length); but in this fish also the gripping quality of the lower enlarged lip is so convincing that it leaves no doubt that it is a specialization enabling it not only to seize insects, but also to hold them until back in the water again where it swallows them. I have repeatedly observed their unerring skill in catching insects both in the aquarium and in the streams. A small pocket electic torch fixed by wires and suspended above the open end of the aquarium with the bulb facing upwards furnishes a simple device which attracts numerous flies at sundown and the fish are then seen to perfection demonstrating their ability in rising and taking the flies they want. Undesirable insects, mistakenly seized, are rejected below the water line by a process of blowing them out from the mouth, and in this act the protraction of the lower lip is markedly noticeable. The stagnant pools obviously offer better breeding facilities and attract many insects and the presence of these fishes in such habitats is so explained. One sees a similar upward formation of the mouth in the species of Chilwa—*Chela clupeoides* (Bloch) [Bhil name, *Jhal*]—which is also insectivorous, but the mouth in this species is large and capacious and hence perhaps the need for the development of the lower lip has not arisen as in the case of the two new species, which are comparatively smaller than other Cyprinoids which live on insects, and therefore need some such specialization in a small mouth to ensure success. It may be that certain tadpoles use the hypertrophied lower lip in a mechanical way to aid respiration. Their breathing apparatus in the transitional development from purely aquatic to terrestrial life probably, at a certain advanced stage, allows for breathing in air directly. In the case of the two new Deolali Cyprinoid fishes there is no evidence that they at any time use their enlarged lower lips to hang in a mechanical way from the surface film to aid respira-

tion. On the other hand there is convincing evidence that they have a capacity for living in the foulest of waters without ill effects[1] and the smaller forms of this species that do so are definitely larvivorous and insectivorous as the stagnant habitats attract numerous insects and ensure a varied and plentiful food supply. The very young ones of both the new species are unable to swallow the larger Culicine larvae but easily devour the smaller Anopheline larvae and those of midges. These very young fishes were recovered during November. Egg-bearing females were found in February.

Barbus khudree Sykes—Bhil name, *Warris*.

This fish has two pairs of barbels. It is silvery white and slightly discoloured dorsally. It favours strong currents in the rivers. It does not live for more than half an hour in a receptacle of water. On this account no observations could be made.

Barbus ticto (Ham.).—Bhil name, *Tiptoo* and *Tiplee*.

This surface species appears to be the dominant type in the rivers. They are localised in sections having villages situated directly upon the banks and here they are very numerous, particularly if the village is a large one with a big population. They are found only in those parts of the tributary streams which run through largely populated areas, such as in the 'North Nallah' up to a point near to Deolali Cantonment Bazaar and the 'Narsullah Wadi' near to the village of Bagoor, and the section which runs through Barnes High School estate, where they are found in relatively small numbers. They are singularly absent in the stretches of both the rivers and streams which meander through open country or tracts given over to cultivation and where there is a complete absence of human habitations. In sections of these open stretches where there is an occasional hamlet or two, they can be got, but only in very few numbers. They favour the shallow edges of the rivers up to a depth of two feet, where the currents are of slight intensity. In the streams they favour stagnant pools or those with a slight surface flow. All the specimens of this species taken from the Godaveri river on 8th December 1935 (batch No. 28) and from the Narsullah Wadi on 19th January 1936 (Batch No. 35) showed a markedly scarlet pigmentation of the body scales; and the caudal, dorsal and ventral fins were similarly stained. On the 8th December 1935, the water in the Godaveri river was very dirty looking, ashen in colour and with green algae, largely in evidence, floating in fragments on the surface scum. Much of their red colouration has been lost through storage in spirits. In other areas, an occasional scarlet stained specimen was recovered. Normally they are silvery white and stained dorsally; with muddy coloured fins and black rays. When kept in an aquarium they lose all the dark staining becoming silvery white

[1] The surface water is, as a rule, better oxygenated, so the surface fishes do not in reality live in very foul waters. It seems also probable that the respiration is aided by taking in gulps of air, as most of the Cyprinoids do, and passing them over the gills.—*S. L. Hora.*

with very pale fins. They do not for the first week readily feed on the larvae of mosquitoes, but in the course of time and due to the absence of other food, ultimately become larvivorous. They then show much greediness. They also feed on green algae, the dough of any flour and ground particles of roasted 'Bajri' grain. Very young specimens were recovered from the streams during November 1935. Egg-bearing females were found in March 1936.

Garra mullya (Sykes).—Bhil name, *Mallia.*

The mouth of this species points downwards and there is a suction disc on the ventral aspect of the mouth. It is a very dark coloured fish with black fins and the suggestion of a lateral line, as the perforated scales are ill defined against the dark discolouration of the body. These lateral scales are complete. It is found in sections of the rivers and streams which flow over beds of rock. It favours fairly strong currents and depths. Although showing a degree of susceptibility, the species can live for 2 to 3 days in an aquarium. Their behaviour in the aquarium has been described in the previous notes under mortality rates. When lying on the floor of the aquarium the mouth movement in the act of respiration is at a slower rate than that of the surface fishes. They move along the floor with a leaping and wriggling movement. I have not been able to ascertain what they feed upon but since they favour a rocky bed the diet may be a form of algae growing on the rocks. They are generally distributed in both the rivers and streams. Egg-bearing females found in March 1936.

Labeo porcellus (Heckel).—Bhil name, *Khanoos.*

It favours sections of the rivers where there are fairly strong currents and the bed is rock or pebbled and part silted. It is dorsally an elephant grey and laterally and ventrally silvery white. The fins are dark coloured. As it does not survive when removed from its natural environment, no observations could be made.

Cobitidae

Nemachilus botius (Ham.).—Bhil name, *Mohroo chickna,* is a leopard spotted variety. The colouration is a yellow background with black spots and bars and dark yellow fins. *Mohroo chopra* [*Lepidocephalichthys guntea* (Ham.)] is a dark coloured fish with dorsal spots and mottling with a clear black line. It is very thin and attenuated in form. *Mohroo yaree* [*Nemachilus denisonii* (Day)] is a banded variety. The bands are dark and broad and run transversely from the dorsal ridge to the ventral surface.

Mohroo thail resembles in colour *chopra* but the tones are much lighter and it is definitely stouter and heavier in formation.

The Cobitidae are found generally distributed in rivers and streams. They favour the rocky sections and silted and sanded beds where there is evidence of algae growing from the rocks and sides of the rivers. The banded variety, namely *Mohroo yaree,* is more numerous and associated with *Rasbora labiosa* Mukerji at the heads of the streams. They hug the edges of the rivers and the streams where the currents are not too strong.

Lepidocephalichthys not only move their lips in the act of breathing but also rise to the surface to take in air. They do

this about 12 to 15 times in an hour. They feed well on green algae growths especially the variety which grows on and clings to rocks. When kept with other surface fishes which were fed on the larvae of mosquitoes they were observed in the act of swallowing the larvae. A curious trait noticed is their habit of mouthing the bodies of surface fishes, when these latter were resting stationary a little above the floor of the aquarium. The surface fishes do not resent this action. They are also fond of pushing themselves up the glass surface of the panel, nibbling, as they move, particularly when the panel is covered with a scum of fine earthy particles and slime. These species move along the bottom of the aquarium with a wriggling motion much like a snake and can cling to and climb up an almost upright glass panel. In this respect they show undoubted scansorial powers.

Mystus cavasius (Ham.).—Bhil name, *Khirkirya.*

This cat fish has proved to be a good aquarium fish. They behave much in the same way as surface fish do and regularly exercise themselves by swimming at the surface every evening. During the day they rest at the bottom of the aquarium all huddled together but show the greatest activity at night. They are silvery with a greenish tinge and the fins are light in colour. They feed readily on mosquito larvae and also on worms which they prefer. They are able to move the eye forwards, upwards and downwards. They are susceptible to strong sunlight and show a photophobia and strive to conceal the head by efforts to get under each other or, if there is algae in the water they hide in them. They favour sections of the rivers which have a broad expanse and where the bed is rocky and part silted and are found at the edges at depths up to three feet in currents of mild intensity.

Glyptothorax lonah (Sykes).—Bhil name, *Khardoo.*

It bears a close resemblance to the *Goonch.* When freshly caught and alive, the colour was strikingly beautiful. It lived for barely fifteen minutes and lost colour through storage in preservatives. Originally the post-mortem white markings were a bright red both on the body and the fins and belly and the dark background now seen was a jet black colour.

Nangra viridescens (Ham.).—Bhil name, *Biboa.*

When freshly caught, the colour was a rich gold with some black dorsal markings. They lived for only a half hour and were taken from the Aounda and Darna rivers. It is a recessive type as only a very few were taken.

Ophicephalidae:—There are two species with the following Bhil name:—(1) *Dhakay* or *Dhakaray* (*Ophicephalus gachua* Ham.) is a black fish with the terminal ends of the caudal fins stained a brick red, which fades in preservatives; (2) *Murral* (*Ophicephalus marulius* Ham.):—Dorsally and laterally greenish brown. Ventrally white and a well-defined ocellus superiorly placed upon the caudal fin.

Both species make good aquarium fishes but they are unsociable and attack and kill each other and hence cannot be left together. Both can be kept with other species provided they are regularly fed with worms and bits of meat (raw). If hungry they devour

the smaller surface species. They appear to be nocturnal in habit as they then manifest the greatest activity by endeavouring to leap out of the aquarium. One kept in a jar by itself succeeded one night in getting out of it. This it must have done at some time after eleven o'clock, when the fishes in the aquarium and those in other receptacles had been inspected by me before retiring for the night. I found this *Dhakay* specimen at six o'clock next morning on the floor to all intents apparently dead. Its skin was dry and hard as a board and the only evidence of life it showed was the fitful movement of one of the forward fins. I placed it in water and it slowly recovered taking in all six hours before regaining its normal state. *Dhakay* are found everywhere both in the rivers and streams. The other species has been taken only from rivers and is also found at the junctions of the streams with the rivers. Both species hug the edges at depths up to two feet and prefer silted areas grown with aquatic vegetation. In the aquarium both rise to the surface to take in air about fifteen times in an hour and always sink back tail first to the floor. They do not normally, when at rest, work the mouth in the act of breathing, but do so only when exercised or under stress of excitement as when engaged in chasing, biting and killing each other. In the absence of the food mentioned they readily swallow the larvae of mosquitoes.

Glossogobius giuris (Ham.).—Bhil name, *Kharbiya*.

Dun or olive coloured background, varying in shade with dark spots laterally and dorsally in the nature of blotches and also on the head.

Kharbiya have been taken from sections where the bed is rock or sand and appear to favour strong currents. Curiously enough they work the mouth in the act of respiration at a slightly slower rate than that of the surface species. They are capable of living in the aquarium for 4 to 5 days only and this inadaptability can be attributed to the absence of currents. I have not been able to ascertain what they feed upon. In all probability their food consists of small crustaceans.

3. A Note on the Fixed Practice as Observed Amongst Certain Species of Fish of Regularly Exercising Themselves every Evening by Swimming about at the Surface Film in the Rivers and Also when Kept in an Aquarium.

The following species were observed for five months. They were kept in large-sized glass receptacles (accumulator jars) which had a surface expanse of 22 inches and a depth of 18 inches of water (approximately six gallons) in each. Other containers such as slop pails (Enamel iron) of four-gallon capacity were also used. About a dozen and a half fishes were kept in each of these containers for which net covers were provided. The species are as follows:—

(1) *Barbus ticto* (Ham.):—Bhil name: *Tiptoo*
(2) *Rasbora labiosa* Mukerji:—Bhil name: *Gayroonjee*
(3) *Danio fraseri* Hora:—Bhil name: *Gayroonjee*

(4) *Barilius bendelisis Ham.* :—Bhil name : *Jhor*
(5) *Mystus cavasius* (Ham.) :—Bhil name : *Khirkirya*
(6) *Ambassis ranga* (Ham.) :—Bhil name : *Bing*
(7) *Ophicephalus marulius* Ham. :—Bhil name : *Murral*
(8) *Giossogobius giuris* (Ham.) :—Bhil name : *Kharbiya*
(9) *Ophicephalus gachua* (Ham.) :—Bhil name : *Dhakay*
(10) *Garra mullya* (Sykes) :—Bhil name : *Kharandya* and *Mallia*

Excepting (6), (7), (8), (9) and (10), in the aquarium, the first five species, regularly every evening for about two hours between 4.30 and 8.30 p.m. rose to the surface to exercise themselves in much the same manner as has been described under the habits of *Rasbora labiosa* Mukerji. This form of exercises is unattended by any mortality and the fishes do not show any symptoms of dyspnœa. There is evidence also that other surface fishes belonging to the family *Cyprinidae* carry out this practice as a regular feature every evening in the rivers, but as most of those taken from rivers invariably showed a high degree of susceptibility to aquarium conditions, with a cent per cent. mortality incidence, it was found impossible to discover how many of the various species conformed to this practice. It may be remarked that in a general way it is a habit prevailing amongst the majority of surface fishes and at first, it was thought that only such species as are purely insectivorous rise to the surface and swim about in order to feed. This was however later disproved by the observations which were maintained in the aquarium over the five species already mentioned. All resorted to the practice at the regular time even when they had been fed to surfeitment with larvae and imago of mosquitoes and midge flies from 2 to 4 p.m.[1] This experiment was repeated daily for many months and the fed series showed no deviation from the rule, as they instinctively responded to the urge at the regular time as usual without evincing any desire for food although the opportunities offered. The control series which were sparingly fed combined the exercise with attempts to feed by devouring larvae and leaping to take the insects flying above the water level. This evidence led to the consideration that, as the exercise appeared to be a purposive act not specifically associated with hunger, there was some other physiological cause underlying and governing this peculiar behaviour. What this cause may be is, of course, a matter for conjecture. The following notes outline the line of investigations which was followed in an endeavour to find a solution for this enigmatical behaviour of surface fishes and from the facts obtained by experiment and observation a working hypothesis is offered which might possibly help other workers competent to deal with and solve the problem.

It was thought that variations in the temperature of water at various times of the day and evening possibly influenced the fishes

[1] My observation and experience with numerous species of *Cyprinidae* in China and the Philippines is that this peculiar practice is a regular feature in the early morning, from before 6 o'clock until 7 or 7.30 a.m. or until the sun's rays strike the water. The fishes swim at the surface, opening and closing the mouths as if sucking in air.—*Albert W. C. T. Herre.*

to act in the way they do and so an inquiry in this direction was instituted and extended over a period of several months. These temperature differences will be found recorded subsequently. It may be remarked that, in a general way, the variations in the temperature of the water in the rivers and in the aquarium do not appear directly to influence the behaviour of the fishes as regards their evening exercise. The surface species in the rivers were sometimes seen to rise and swim about at the surface during the mornings and, on occasions, also in the afternoons; but they do this only when a high prevailing wind ruffles the surface and beats it into wavelets. On these occasions it is evident that they come up to the surface actuated by a desire to feed as the wind brings with it a supply of insects for which they actively leap out above the surface film. They nevertheless rise as usual in the evening and go through with their exercise whether a wind is blowing or not. During the dry and hot months of the year—April for example, when the maximum shade temperatures swing between 98° and 106° F.—the temperature of the surrounding air varies and is 5 to 20 degrees higher than the temperature of the water in the rivers; whereas during the cold months (December and January) the temperature conditions are reversed and the air is then colder by about 4 to 20 degrees. In the cold months, a constant feature recorded was that there was a surface coolness of the water in the rivers and also in the aquarium of one degree as compared with that in the depths below. The temperature in the deep parts of the river was ascertained by means of a weighted thermos flask containing a bath thermometer and two open tubes, one running from outside through the stopper to near the bottom of the flask for entry of water and the other ending just under the stopper to let the air out. During the hot weather a surface coolness of half a degree becomes apparent but only at a time when there is a prevailing wind and only in the sections of the river where there is a wide surface expanse with a weak midstream current. In the absence of a wind, there is no difference between the temperature at the surface to that in the depths below and this is also the case in the sheltered pools and narrow parts of the stream and rivers. In the aquarium likewise, there is no difference between the surface temperature and that below in the depths unless the receptacle is well ventilated and placed in a position open to draughts of air and even then the coolness is barely fractional. When the receptacle contains clear well-water, subject to daily changes, the fishes rise and swim about at the surface only once daily every evening for about two hours. This they do apparently quite independently of the temperature conditions, which in the cold weather vary from 56° to 86° and in the hot weather from 74 to 96°F. On the other hand, if the water in the receptacle is rendered turbid with a heavy suspension of mud the fishes rise and swim about at the surface and begin to show some respiratory embarrassment. A few die if the suspension of mud is too thick. They continue to keep at the surface for as long as the water remains muddy. When the mud finally subsides they sink below once again. In such a water they

tend to keep towards the surface film as the supernatant fluid is generally clearer and less difficulty in respiration is experienced. When the evening hour arrives they begin the exercise as usual.

A striking fact which emerged from the observations is that when the fishes in the receptacle have exercised themselves in the manner described for an hour or so, patches of frothy bubbles are noticed floating or clinging to the sides of the glass panel and these frothy bubbles were absent prior to the exercise. This is a constant feature but it could not be ascertained whether the fishes give out these bubbles or whether they become created mechanically by them in the act of vigorously swimming at the surface. As the appearance of the bubbles is a phase dependent upon the peculiar exercise of the fishes, there is a definite association between the two, and for this reason it would seem that the fishes themselves emit a gaseous discharge while in the act of swimming and this must come from the mouth in the form of tiny invisible particles which, when at the top, coalesce to form the larger visible bubbles normally seen. In the aquarium these bubbles take a very long time before being finally dissipated as some of the floating patches remain intact until the next morning. In the case of the batch of *Rasbora labiosa* Mukerji, referred to in the previous notes, kept for eleven weeks in the same foul water which was never changed, the bubbles in their receptacle accumulated and assumed large proportions and had the character of the frothy saliva seen issuing from the mouths of rabid dogs. The gas, whatever it be, is enclosed in a viscid mucous substance which does not burst readily.

All fishes in the aquarium rise to the surface when symptoms of respiratory failure ensue and this must be so because of the absence of some of the factors of their natural environment, the chief one of which is the amount of available oxygen in the water in the form of dissolved air, which judging from their behaviour appears to be present in a greater volume at the surface. It is well known that if the air which is dissolved in water be expelled from it, the content of nitrogen in this expelled air is in poorer volume in the proportion of 35.1 oxygen and 64.9 per cent. nitrogen as compared with normal air which has 21 volumes of oxygen and 79 of nitrogen and in all probability the lesser pressure at the surface must also help the fishes to easily absorb both the gases. It is possibly for this reason that the Cyprinoid fishes rise to the surface.

[It has hitherto been casually observed to be a general habit among Indian Cyprinoid fishes of sluggish waters, such as rivers, streams, ponds and pools, to rise to the surface towards the evening and to take gulps of atmospheric air, which is usually passed over the gills. Dr. Fraser's observations show that this is a regular habit among the fishes of this class. Presumably, the passing of the air over the gills tones up the filaments to carry on aquatic respiration for the greater part of the day and night, as Cyprinoids are essentially aquatic breathers.

Dr. Fraser has noticed that frothy bubbles are given out by these fishes and that these bubbles are very sticky. The air which is passed over the gills, which are always covered with a thick slimy secretion, probably carries away with it a certain amount of slime which converts the air-bubbles into a frothy mass. When experimenting with the air-breathing fishes, which use

their gills for aërial respiration, such as the *Mastacembellidae* (*Trans. Nat. Inst. Sci. India*, i, p. 8, 1935), it was noticed that a big frothy mass was produced by the air-bubbles that were given out through the gill-openings. To my mind, Dr. Fraser's observations clearly show that the Cyprinidae resort to aerial respiration for a couple of hours in the evening each day.

As to why the other species of fish enumerated by Dr. Fraser in this note do not swim near the surface in the same way as the Cyprinoids do, the explanation is different for different species. *Ambassis ranga* (Ham.) is very thin and transparent and can probably absorb oxygen all over the surface. *Ophicephalus marulius* (Ham.) and *O. gachua* (Ham.) are provided with special accessory respiratory chambers and are even capable of living in waters totally deficient in oxygen. *Glossogobius giuris* (Ham.) is only slightly adapted to foul-water conditions, but presumably its large gill areas are capable of absorbing a fair amount of oxygen from the water and, unless the water becomes very foul, the fish can extract sufficient oxygen from the water for its needs. Further it is known that species of fish can extract oxygen from water even when the oxygen-tension is very low for a number of normal aquatic breathing fishes.—*S. L. Hora.*]

4. Temperature Variations and Alkalinity of the Water.

Temperature.

Temperatures were taken by means of an ordinary bath thermometer and records were maintained over a period of seven months from November 1935 to May 1936 inclusive. Altogether a total of 315 observations were made in the streams and 330 in the rivers. These totals represent an average of 45 readings taken during any one month, that is, of four registrations made at 6 a.m., 2 p.m., 6 p.m. and once at between the hours from 9 p.m. to 1 a.m. on 12 different days in any one month, which for all practical purposes gives a rough idea of the diurnal ranges of temperature of the water in the rivers and streams in the Deolali area at two seasons, namely:—the cold months from November to February and the hot season from March to May inclusive. Only a few readings were taken at the end of the monsoon period of 1935 and as these records are really in the nature of incomplete data they have not been included in the totals shown above.

These records are shown in the following table:—

During the cold months:—November to February.

	Streams.	Rivers.	Aquarium.	Air.
By Day	60 to 80°F.	66 to 86°F.	66 to 76°F.	50 to 70°F.
By Night	56 to 68°F.	62 to 72°F.	56 to 70°F.	40 to 60°F.

During the hot months:—March to April.

	Streams.	Rivers.	Aquarium.	Air.
By Day	80 to 96°F.	76 to 86°F.	78 to 86°F.	90 to 108°F.
By Night	74 to 82°F.	72 to 76°F.	74 to 78°F.	82 to 92°F.

From the above figures it will be observed that during the cold weather the water in the rivers is slightly warmer than that in the streams. This warmth may be due to the presence of very strong currents, as the temperature of water which rushes strongly was found to be, dependant upon the strength of flow, higher by 2 to 4 degrees than the water in a still pool or that in a stream with a mild surface flow. Conversely during the hot

weather, the streams are warmer than the rivers. This can be accounted for by the fact that in the dry weather there is much less water in the channels of the streams and there is little or no flow which results in a fair degree of stagnation. Some portions of the stream dry up also and the collections of water in the rocky sections of the *Nallahs* become heated.

Surface temperatures of water: It was found that during the cold weather there was a surface coolness of half to one degree as compared with the temperature below in the depths. In the hot weather the temperature both at the surface and below was identical except when a strong breeze was blowing and ruffling the water's surface when a slight fractional coolness was noted.

Differences between the air and water temperatures during the hot and cold seasons of the year: The peculiarities observed were that during the cold weather the air temperature is lower than that of the water in rivers and streams and aquarium by 4 to 20 degrees and it is higher in the hot months by 5 to 20 degrees. In this connection the few observations made during the rainy season showed that both air and water temperatures appeared to vary little and were fairly constant showing a diurnal range of 65 to 74°F.

Reactions of fishes to extremes of water temperature: It was found that the range of water temperature which conduced to a normal activity amongst fishes as depicted by their behaviour was from 65 to 80°F. Any temperature below 58°F. inactivated them as they then tended to remain at the bottom all huddled together and, if green algae are present in the water, they push themselves into its meshy texture. On the other hand a temperature above 84°F. caused them to exhibit a restlessness in the form of an activity confined to swimming about just below the surface film and in doing this they showed an accelerated breathing rate, but with no signs of actual distress. At temperatures above 90°F. symptoms of acute dyspnœa became manifest.

The following experiments were carried out with a view to ascertain the end points of extremes of water temperature which kill fishes and the tolerance of any acquired for heat and cold. The same number of fishes, previously enumerated were employed in these experiments, namely 10 species belonging to both surface and ground types.

(1) The temperature of the water in the receptacle containing these species was gradually lowered by placing blocks of ice around it. By this means it was ascertained that during the cold weather the minimum temperature which killed both surface and ground species is 48 to 50°F. Conversely (2) also during the cold weather, by heating the receptacle in a water bath the maximum temperature at which fishes died stood at between 92 to 94°F. On the other hand similar experiments carried out during the hot weather showed that the minimum temperature at which fishes became moribund and died was 55 to 58°F. and the maximum at between 102 to 104°F. These experiments clearly showed that fishes at the different seasons acquire or lose a tolerance for heat and cold.

How far the temperature variations of the water at the different seasons influence the distribution of the species as betwen the rivers and streams cannot be precisely determined but there is evidence to show that the constancy of water temperatures as has been shown to obtain in the rivers may be a factor controlling the distribution, as the variations of the temperature in the waters of the rivers is within the limits of tolerance for the well-being of fishes and the majority of the species found here have their habitat in the rivers. In this connection it may be remarked that the other factors which play an important part in regulating the distribution of the species are (1) Alkalinity of the waters (2) The presence of strong currents (3) The greater volume of water and the wide surface expanse which so far as the rivers are concerned offer to fishes a better environment than that in the streams. I have previously mentioned that there are only three species which can be regarded as truly stream fishes. Two of these are surface species and curiously enough are quite new Cyprinids described by Hora and Mukerji in the *Records of the Indian Museum,* namely :—*Danio* (*Danio*) *fraseri* Hora and *Rasbora labiosa* Mukerji and the other is a ground species with the Bhil name of 'Kharandya' [*Garra mullya* (Sykes)]. There is enough evidence in the collection made of these species that the adults never attain any large dimensions. In the case of river fishes, with but few exceptions the majority grow to a large size. Judged on this evidence it is apparent that the stream environment is unfavourable to fishes generally and the three species mentioned can be regarded as classic examples of fishes which have completely adapted themselves.

Alkalinity.

This was tested by means of red and blue litmus papers reactions. By this test the water in the streams was found to be more alkaline than river water. Well water was slightly less alkaline than either river or stream water. In certain sections of the streams and rivers, where there was an absence of currents, the water was found to be strongly alkaline especially in those areas which were silted up. In some parts of the rivers the reaction was neutral. In no instance did either river or stream water give an acid reaction.

As regards the pH values, crude water from the river tested at the Military Laboratory, Bombay, was found to have the pH standing at 8. Reaction alkaline, turbidity present, free ammonia in a trace. Hardness under 4 degrees. Chlorides 2 parts chlorine per 100,000.

In a slightly acidulated water stream fishes will live for $\frac{1}{2}$ to 1 hour. In distilled water with a neutral reaction stream fishes lived for 3 to 6 hours.

In tap water boiled and cooled and giving a neutral reaction stream fishes showed no distress and lived for several weeks without the water being changed, nor did they die when restored to an alkaline water taken from a well.

Mention may be made of the fact that *Barilius bendelisis* (Bhil name 'Jhor') was found in somewhat brackish waters. It would appear that a slightly alkaline water suffices for the majority of the fishes in the streams and rivers in the Deolali area.

5. Miscellaneous Notes.

Sleeping habit of the Ophicephalidae.

The two species of fish known to Bhils by the names of *Dhakay* (*Ophicephalus gachua* Ham.) and *Murral* (*Ophicephalus marulius* Ham.) I have been told by Bhil fishermen, have the habit of sleeping on the banks all night. They lie up in the shallows at the edges of the river with their heads partly exposed and this helps them to take air while asleep. There is a good deal of truth in what they say as these species, when in captivity in the aquarium, exhibit a nocturnal activity by endeavouring to leap out of their receptacles and this anxiety would naturally be prompted by the break in the continuity of the habit of resting and sleeping in the way described by the Bhils.

Malformations.

As regards malformations in the body of fishes, there is one specimen of *Rasbora labiosa* Mukerji (Bhil name: *Gayroonjee*) which is of considerable interest as there are several twists in its body length. This specimen when alive behaved quite normally except for a handicap in its swimming speed. The speed was half that of the other normal examples of its species. Another exhibited a tumour-like growth (much like a Goiter enlargement) on the ventral aspect below the mouth. This is important because I have not encountered any malformations in the many specimens of various species taken from the rivers.

Vernacular Names.

The names by which Bhil fishermen differentiate the various species have been cited in the previous notes. They give separate single names to species of the Cyprinoidea, Siluroidea and Ophicephalidae families and in certain examples for some unknown reason assign only one group name to include two or more different species despite the fact that they know them to be distinct types. Only in one case that of the Loaches (*Cobitidae*), do they attempt to separate out the species by employing the group or family word conjoined with another colloquialism to denote the type. I have collected specimens under the names as they were given to me and in this series it will be found that the same names recur for different species. In order to be quite sure that there was a general uniformity amongst the Bhil fishermen in the naming of fishes I obtained information from several fishermen residing in villages as far apart as 20 miles and in each case the vernacular names given by them agreed.